SOUTH DAKOTA AGRICULTURAL EXPERIMENT STATION

Annual Report
of the Director

For the fiscal year ending
June 30, 1920

Brookings, South Dakota

ANNUAL REPORT

Mr. Willis E. Johnson, President,
South Dakota State College.

Dear Sir:

As director, I have the honor to make the following report of the South Dakota Agricultural Experiment Station for the fiscal year ending June 30, 1920.

Organization

The station is divided into five different departments as follows: Agronomy, animal husbandry, dairying, entomology, and horticulture. The head of each department is also professor of the subject in the college. By this arrangement students in the college of agriculture receive benefits derived from the experiments and the head of the department is better prepared to conduct experiments because he is more likely to keep up in his subject. This arrangement, also, provides better men than if each was operated separately.

The Staff

With one exception the personnel of the staff was the same as for the preceding year. Mr. Manley Champlin in the department of agronomy and also collaborator with the United States Department of Agriculture resigned to accept the position of agronomist in the extension division of this institution.

Division of Funds

At the beginning of the fiscal year the Hatch and Adams funds are apportioned to the different departments, but the $30,000 furnished by these two acts must be expended in accordance with regulations made by the Secretary of Agriculture, Washington, D. C.

For 1919 the funds were apportioned as follows:

Hatch Fund

Executive	$ 5,227.00
Agronomy	1,845.00
Animal Husbandry	3,177.00
Chemistry	1,650.00
Dairy	1,759.00
Horticulture	1,342.00
Total	$15,000.00

Adams Fund

Agronomy	$ 4,529.00
Dairy	3,819.00
Entomology	1,692.00
Horticulture	4,960.00
Total	$15,000.00
Grand Total	$30,000.00

Of this amount $17,380.13 was paid for salaries, and $5,204.51 for hour labor during the year, or a grand total of $22,584.64 for employees.

PUBLICATIONS

The law requires that at least four bulletins shall be printed annually. When printers will do so, we usually print and distribute six to ten bulletins; but in recent years the cost of printing has been such that we have been prevented from issuing the usual number. Thirty thousand copies of each bulletin are printed and sent to some 20,000 residents of South Dakota. These bulletins are franked in the mails and are free. We also send hundreds of our bulletins to residents of other states when requested.

There were four bulletins printed during the year as follows:

No. 186—Corn Families of South Dakota.

No. 187—The Influence of Length of Wheat Heads on Resulting Crops.

No. 188—Relative Values of Feed Proteins for Dairy Cows.

No. 189—Corn and Millet Silage for Fattening Cattle.

The state makes a small appropriation annually for printing.

Summaries of Bulletins

The department of agronomy includes the following summary for bulletin No. 186:

1. It is submitted as an expedient of corn breeding, that the mother ears selected for starting a breeding plot should not only be as numerous as practicable; but should also represent as many sources as practicable from among those likely to excel in qualities desiresd. Page 121.

2. For the same reason mother ears should be systematically introduced into the detasseled rows of the breeding plot in succeeding seasons from stocks of other corn breeders and other sources where excellent strains are likely to be found. Page 121.

3. It is submitted as another expedient of corn breeding that high yielding tested remnants should be utilized as largely as possible in making and carrying out plans for corn breeding by selection. Page 122.

4. Detasseling all the even-numbered rows in the breeding plot insures that the progeny of these rows will be crossbred. Page 124.

5. All of the twelve odd-numbered (sire) rows in any given quarter of the breeding plot can be planted from one

single ear, providing the rows in the breeding plot are short —(ten hills). This sire ear may be selected from the highest yielding row of another quarter, according to plan. Pages 122 to 124.

6. The foregoing expedients may be employed in securing the production of seed corn, which is the product of crossing strains that are selected for high yield (or any quality) that are selected continuously and whose sires and dams may have approached a homozygous condition.

7. It is practically possible to record the ancestory of ears of corn from such a breeding plot to preserve a working pedigree record of such ancestry. Page 124.

8. The "variety" of corn named "All Dakota," produced according to the foregoing expedients, should ultimately represent a combination of high-yield characters now existant in varieties that are successful in eastern South Dakota; such as Golden Glow, Minnesota 13, Fulton Yellow Dent and Wimple's. At the time of writing the surplus (15 acres) from the 1918 breeding plot is growing on the farm of Percy Ullman, in Brookings county.

Bulletin No. 187

The department of agronomy includes the following summary for bulletin No. 187:

1. Practically, it would be helpful in wheat breeding to know whether one could depend on picking out the relatively longest (and accordingly finest appearing) heads, as a method for securing the highest yielding strains.

2. The results of the present experiment indicate that relatively long heads did yield slightly higher than similar heads on other plants, in the first generation after the selection of mother heads.

3. Whatever may have caused the slight increased yield in the first generation, it failed to persist in following generations; which were produced from seed tracing back to the original mother heads, but without additional selection.

4. At any rate so far as one may generalize at all, the plant may be used as a unit of selection, and the length of central spike cannot be considered as an indicator of the fitness of a given plant to serve as the mother plant of a line of progeny.

Bulletin No. 188

Bulletin No. 188 by the department of dairying includes the results of an investigation as to protein requirements for dairy cows and is summarized as follows:

1. The question of the proper interpretation of results obtained from substituting one protein feed for another in the ration of a cow producing milk is a difficult one.

2. Because of other factors which might affect the results, (the most important of which are probably energy supply and variations in production of milk) it cannot be said that the most valuable protein is always the one which in least quantity establishes and maintains approximate nitrogen equilibrium.

3. Unless the energy content of the ration is abundant a part of the protein will probably go to satisfy energy requirements rather than nitrogen requirements.

4. Average percent availability of oilmeal and gluten food in establishing a nitrogen equilibrium was oilmeal 52.4 percent and gluten feed 76.4 percent or as 1 is to 1.46.

5. In all but two instances gluten feed protein seems to show a higher relative value than oilmeal protein. This higher value, however, may be due not necessarily to the source of the protein, but possibly in part to the increased percentage of therms net energy in the hay and silage.

Bulletin No. 189

Bulletin No. 189 from the department of animal husbandry, includes results of two experiments with feeding cattle on silage and is summarized as follows:

1. A choice silage was secured from corn when cut at time of tasseling and also from millet when about 90 percent of grain was ripe.

2. The steers that received shelled corn, oilmeal, and hay did not bring enough more on the market over the lot that received corn silage and oilmeal to justify the feeding of this comparatively expensive ration.

3. The best gains were secured in feeding silage made from White Dent corn, medium sized, a variety that matures ears before frost. This variety has been used at this station for several years and results secured in each experiment have been extra good; hence, we recommend this as a suitable variety to grow for the cattle feeder.

4. Results indicate that an emergency crop corn is superior to millet when both are made into silage.

5. The results from feeding silage made of Rainbow Flint corn were practically as good as results from feeding silage made from the dent varieties; but the yield of flint was larger per acre and in sections with short growing seasons it might be advisable to grow this kind in preference to the dent varieties.

DEPARTMENT OF ANIMAL HUSBANDRY

Three experiments were conducted in the department of animal husbandry during the past year, as follows: Feeding Silage to Steers; Feeding Grains and By-products to Pigs; Development of a Breed of Sheep.

It was found that beef could be made to good advantage with proso silage; that cattle fattened on proso silage were worth nearly as much in the market as those fattened on shelled corn and hay; that when we consider the labor involved in producing the proso silage its use for this purpose should be extended throughout the cornbelt.

Sunflowers were grown, made into silage, and fed to a lot of cattle but because of the unfavorable condition of the season for this crop it was deemed better not to report results in bulletin form until the experiment had been repeated.

Another lot of steers was fed on immature corn silage with good results, which shows that corn has a high feeding value even if siloed before the plant reaches the tasseling stage. During the 120 days feeding period an average daily gain per head of 2.09 pounds was secured and the cattle brought only 35 cents less per hundred in the market than cattle that had been fed on shelled corn and hay.

The proso lot made an average daily grain per head of 1.82 pounds and brought 60 cents less per hundred pounds than the shelled corn and hay lot.

Our results with the corn silage lot confirm results received with other lots of steers at this station, that it is the cheapest way we have found to produce a pound of gain. For this lot we secured an average daily gain per head of 2.32 pounds as compared with 2.60 pounds for the lot that did not receive silage but shelled corn and hay for the same feeding period. All these steers received three pounds of oilmeal per head daily.

Grains and By-Products for Pigs

This experiment may be divided into four parts: 1. A comparison of fishmeal and tankage as a protein supplement. 2. A comparison of the feeding value of shelled corn and ground barley. 3. A comparison of several methods of feeding barley. 4. Value of bluegrass pasture in fattening pigs on corn and barley. These experiments covered a period of 105 days and the results may be summarized as follows:

1. Fishmeal vs. tankage.

This experiment was conducted in cooperation with the Bureau of Animal Industry, United States Department of Agriculture, Washington, D. C. The fishmeal is a by-product

of the fishing industry. The results obtained in this trial where all feeds were self-fed indicate that fishmeal has a very high feeding value and ranks with tankage as a source of protein for supplementing corn when fed to fattening pigs. Pigs receiving shelled corn and tankage made an average daily gain per head of 1.42 pounds and those receiving shelled corn and fishmeal 1.47 pounds.

2. Shelled Corn vs. Ground Barley.

Two lots of eight pigs each were self-fed shelled corn and tankage and ground barley and tankage. The pigs that received shelled corn made an average daily gain per head of 1.42 pounds while the pigs that received ground barley and tankage made an average daily gain per head of 1.33 pounds. In this trial 13.3 percent more grain was required by the barley lot to produce 100 pounds of gain than with the corn lot. The results also indicate that when ground barley and tankage are self-fed in separate compartments the pigs may consume more tankage than is needed to balance the ration. It would undoubtedly be more economical to limit the amount of tankage fed with ground barley. Barley is an important crop in this state and may often be used as a substitute for corn in fattening pigs.

3. Methods of Feeding Barley for the Production of Pork

Three lots of eight pigs each received the following rations: Whole dry barley from a self-feeder; ground barley from a self-feeder; and soaked whole barley, hand fed. Each lot received tankage from a self-feeder. The results indicate that ground barley from a self-feeder was the best of the three methods. Soaked whole barley was second best, and whole barley from the self-feeder was the poorest. The gains per head daily were 1.33, 1.23, and .90 pounds respectively. The amount of feed required for 100 pounds of gain was less with the ground and soaked barley lots than with the whole dry barley lot, being 378, 402, and 433 pounds respectively. The pigs fed the dry whole barley consumed 110 pounds of tankage for every 100 pounds of gain made which is an excessive amount of protein supplement.

4. Bluegrass Pasture vs. Dry Lot.

Pigs on bluegrass pasture received shelled corn and tankage (self-fed) made an average daily gain of 1.69 pounds while pigs fed on same concentrates in dry lot gained only 1.42 pounds, or a difference of .27 of a pound daily in favor of the bluegrass pasture. Again, pigs receiving ground barley and tankage on bluegrass pasture made an average daily gain of 1.51 pounds as compared to 1.33 for lot that received same feeds but without bluegrass.

Bluegrass pasture is also valuable when economy of production is considered for when corn was fed the amount required to produce 100 pounds of gain was 14.8 pounds less than in the dry lot. In the case of barley the pasture effected a saving of 15.8 pounds of barley and 19.6 pounds of tankage for every 100 pounds of gain.

The results of this trial indicate that a forage crop like bluegrass increases the daily gains and reduces the amount of expensive grains and concentrates required to produce gains, but increases quantity of grain consumed.

Sheep Breeding

While Professor N. E. Hansen, horticulturist of this station, was in Siberia in search of new varieties of plants he bought and presented to the animal husbandry department six head of sheep known as the "fat-rump". This is the only flock of this breed in the United States, and because of some valuable characteristics not found in other breeds we now have, we concluded it would be well to attempt to combine these characters with those of other breeds with a view of selecting a strain better suited to our conditions. Frequently, this breed is confused with the "fat-tailed" breed; but these sheep have no tails.

The lambs of this breed at birth have more vitality than lambs of other breeds and this feature alone would mean much to the sheep grower on the range. Again, this breed comes from the home of the camel where it is extremely dry in summer and cold in winter. The camel stores his fat on his hump and this sheep stores fat on his rump. This stored fat is used in case it is needed for the support of the body. There are certain times of the year in our range country when thousands of cattle and sheep die because of the deep snow. Professor Hansen thought probably this breed would live through a time of this kind: hence their great value to the western ranchman. Parties who have used the half-blood rams are well pleased with results so far.

Our aim is also to develop a breed that does not require docking. A few cross-bred lambs have the short tails and it is just possible that we will be able to succeed in this line. We have but a small flock at the station and have none to sell or trade.

Black-Leg Vaccine Distribution

This department has sent out thousands of doses of government black-leg vaccine during the year. Much time is saved in the distribution by keeping a supply here, and all are welcome to it gratis, providing they will report results to the government.

Finances

The following is a report of the secretary, R. A. Larson, of receipts and disbursements for the year:

EXPERIMENT STATION AND SUBSTATIONS

Receipts 1919-1920

	Home Station Brookings	Highmore Sub-Station	Eureka Sub-Station	Cottonwood Sub-Station	Vivian Sub-Station	Miscellaneous	Total
Hatch	$ 15,000.00	$	$	$			$ 15,000.00
Adams	15,000.00						15,000.00
State Appropriations		3,000.00	3,000.00	3,000.00	3,000.00	1,500.00	13,500.00
Land Endowment						7,021.17	7,021.17
Sales of Produce	4,498.63	1,477.09	925.73	459.12	2,049.78		9,410.35
Balance on Hand— July 1, 1919	4,032.77	396.00				6,948.63	11,377.40
Totals	$ 38,531.40	$ 4,873.09	$ 3,925.73	$ 3,459.12	5,049.78	15,469.80	71,308.92

EXPERIMENT STATION AND SUBSTATIONS
Disbursements, 1919-1920

	Hatch	Adams	Home Station	Highmore Sub-Station	Eureka Sub-Station	Cottonwood Sub-Station	Vivian Sub-Station	Total
Salary	$ 8,119.26	$ 9,260.87	$	$ 2,098.33	$ 2,193.33	$ 1,753.32	$ 2,332.96	$ 25,758.07
Labor	2,366.10	2,838.41	514.38	1,590.44	1,676.55	1,622.48	1,595.47	12,203.83
Publication	1,980.55	.....	.....	12.72	.....	.....	.....	1,993.27
Postage and Stationery	79.91	1.65	37.33	.....	8.22	4.54	30.82	162.47
Freight and Express	152.27	78.72	27.49	63.54	159.51	97.73	32.02	611.28
Heat, water and light	3.60	.....	2.25	774.76	27.47	18.36	256.37	1,082.81
Chemistry Supplies	5.80	155.37	44.35	73.46	45.02	50.12	.....	374.12
Seeds, Sundry Supplies	450.36	625.44	.....	146.78	.80	102.28	191.38	1,517.04
Fertilizers	.....	28.48	.....	.....	.....	.....	.....	28.48
Feeding Stuffs	856.55	549.38	1,847.19	101.15	230.70	688.30	2,114.04	6,387.31
Library	48.88	78.17	129.45	.....	.....	.....	.....	256.50
Tools and Implements	454.83	28.75	135.03	247.17	264.29	876.90	501.15	2,508.12
Furniture and Fixtures	30.00	73.00	91.75	.....	90.70	104.75	.....	390.20
Scientific Apparatus	205.38	655.30	11.38	339.60	641.35	.....	.....	1,853.01
Livestock	.....	244.00	.....	.....	17.50	38.50	383.50	683.50
Traveling Expense	232.26	382.46	675.07	76.96	79.92	178.65	70.60	1,695.92
Buildings and Repairs	14.25	.....	449.00	501.80	56.00	237.20	1,173.70	2,431.95
Miscellaneous Supplies	.....	.....	68.10	461.34	363.26	214.54	309.29	1,416.53
Totals	$ 15,000.00	$ 15,000.00	$ 4,032.77	$ 6,488.05	$ 5,854.62	$ 5,987.67	$ 8,991.30	$ 61,354.41

Popular Bulletins	1,478.40
Highmore Water Works—On Hand July 1, 1920	396.00
Popular Bulletins—Reverted to State Treasury	21.60
Balance on hand Local Fund Home Station, July 1, 1920	4,498.63
Balance on hand Sub-Station, July 1, 1920	3,559.88
GRAND TOTAL	$ 71,308.92

To furnish the best report, possible, of the station I inclose and make a part of this report, a statement from each chief of division to me.

Respectfully submitted,

James W. Wilson,
Director of the South Dakota Agricultural
Experiment Station and Animal Husbandman.

DEPARTMENT OF AGRONOMY

Director J. W. Wilson,
South Dakota State College.
Dear Sir:

May I be permitted to submit the following brief annual report of work accomplished during the past fiscal year in the agronomy department, with especial reference to projects conducted under Hatch and Adams funds:

Adams Project No. 1.

A Project on the Influence of Rotation Upon the Maintenance of Soil Fertility.

Progress has been made with completing the analyses of a second series of soil samples taken from the series of plots on our east farm involved in this project. During the past year, Mr. Howard Loomis practically completed analyzing the second series.

Total nitrogen, total phosphorus and total carbon has been determined in the second series of samples. This series of analyses is now being completed by Mr. Alfred Bushey, who has become agronomy analyst since Mr. Loomis resigned.

At an early date it will be possible to summarize the results of this project in bulletin form and we will accordingly not attempt to state detailed results or draw conclusions here.

Adams Project No. 2

A Study of Correlations Between Certain Physical Characters of Plants and Their Capacity for Yield.

During the year past the results of this project up to date have in large part been published in our experiment station bulletin No. 187, entitled "The Influence of Length of Wheat Heads on Resulting Crops." This bulletin is now available for distribution upon application to the director of the experiment station. It is once more demonstrated apparently from the results of this project up to date that we have no permanent variations within a pure line. The strain of wheat employed in working out this project was Minnesota 169. In the first year of selection, it appeared that long heads of wheat from selected mother plants were correlated with slightly higher yields of progeny. This apparent variation however disappeared in later years of selection which in fact accords with the general theory previously indicated. The following summary appears in bulletin No. 187 which also gives results in the form of tables of correlation between length of head of mother plant and yield of progeny.

This correlation project is being conducted with the use of Marquis wheat. In the present season a new set of mother plants has been planted in the nursery by Mr. Fowlds and is now about ready to harvest.

Adams Project No. 3

A Project to Determine Definitely the Extent to Which Water is a Limiting Factor in the Growth of Sweet Clover (Melilotus alba.)

This project is completed and is now discontinued in favor of Adams Project No. 4. The results of Adams Project No. 3 will be embodied in Bulletin No. 191, now in the hands of the director and ready for the printer. Bulletin No. 191 will be available for distribution when printing is completed and details may be secured therefrom. The following is the summary:

Summary of Bulletin No. 191

1. Sweet clover (white) will apparently live in the loam soils employed in the present trial with as little moisture as nine percent of the dry weight of the soil in which it grows. On the clay soil employed in this series sweet clover appeared to cease growth when the percentage of water on the basis of the dry soil approached eleven percent as a minimum. It is thus indicated that even under conditions otherwise identical variations in soil type may produce some variation in the amounts of water necessary for growth of sweet clover. The observation that soil-type, regardless of other conditions may furnish a factor influencing "water-requirement" is in substantial agreement with other investigators. Pages 4, 7, 25, 26.

2. When the factor of soil type was equalized, it was observed that as the percentage content of moisture in soil was increased, the total amount of water utilized by the plants increased. With increase of moisture content by degrees, in soil, from nine percent, to a minimum of thirty-two percent, the total water used increased regularly from 6.6 kilos to 79.0 kilos. Thus in general, sweet clover plants can make some growth with very limited moisture, but if water is available to them, they can adapt themselves to use it. Pages 25, 26.

3. It is also apparent that the average production of dry matter per plant increased with the total amount of water utilized. Page 25.

4. One chief factor in the increase of dry matter of sweet clover produced with the increase of available water was the increase in height of main stems; the extreme height of plant (main stem) was found to increase, with the

increase of water available, up to 22 percent of the dry weight of soil. When the percentage of available water was still further increased the corresponding increase in dry matter apparently was produced not by increase in extreme height, but by increase in number of stems and branches. Such was the means by which sweet clover plants adapted their manner of growth to the increases in water. Page 29.

5. Also in regard to the manner of growth of sweet clover plants as affected by increases in amount of water; it appeared that the average weight of the leaves of the plants increased, and that the mean area per leaf increased with increase in the amount of moisture available. This statement is based on measurements made in 1918. Pages 29, 30.

6. It appeared that the average actual "water-requirement" (as indicated by the ratio of grams water used to grams of air-dry tops produced) increased with an increase in the amount of the water available, up to 18 percent of the weight of soil, possibly beyond. In short, sweet clover will not only utilize total water within limits when it becomes available, but also will utilize more water per gram of dry matter up to a maximum. Pages 25, 26.

7. The present researches indicate that as an average on all soils the water-requirement for sweet clover varies according to the percentage of water available, from 675 to 789. Page 28.

8. These figures for water requirement as determined agree substantially with those furnished by Briggs and Shantz, for conditions at Akron, Colorado, they having secured a water requirement of 770. Page 58.

9. Sweet clover may be said to have an average water-requirement, as compared to plants listed in general; tumble weed with 277 and millet with 310 are among the lowest and brome grass with 1016 highest in respect of water requirement. Page 58.

10. Previous to beginning the present researches, South Dakota Experiment Station published bulletin 151, "Trials with Sweet Clover as a Field Crop," which indeed may have been the earliest bulletin published giving results with growing, harvesting and feeding the plant in question as a harvested crop. At the beginning of the present researches, it was intended to get quantitative information about the capacity of the sweet clover plant to adapt itself to a wide range of cropping conditions. It becomes more apparent that sweet clover possesses that range of adaptability. In spite of some limitations as a crop-plant, it may well increase in importance as a farm crop, in South Dakota and throughout the world.

Adams Project No. 4

A Project to Determine Definitely the Effect of Phosphorus in Different Forms on the Growth of Plants and the Effect of Sulphur in Combination with Calcium (gypsum-calcium sulphate) and as Pure Sulphur on the Growth of Plants and its Effect on the Availability of Phosphorus in Different Forms.

This project is just starting at the present time. It has been submitted in detail however and accepted and the complete project is on file. It may be well to mention that no field work in involved in the method of investigation, although numerous pot cultures are employed.

Hatch Projects

With Hatch funds, our experiment station plots at Brookings, involving several varieties of the principle cereal and forage crops, have been continued, especially from the standpoint of securing results in terms of crop yield as affected by various rotation systems. It is assumed that these crop yields may not always be interpreted as employing scientific principles reduced to their lowest terms, but that they may oft-times be analyzed in the light of such principles.

A large amount of cereal breeding and selection work is embodied under Hatch funds and this work results practically in the selection and dissemination of important crop varieties. One illustration is Brookings, S. D. 86 Yellow Dent corn, which is a selection from Minnesota 13. This corn has been widely disseminated, especially in the part of the state represented by Brookings area and may be considered and is considered an example of adaptation of a so-called variety of corn to climatic and soil conditions of a given area.

It was noted in the annual report of one year ago that the agronomy department had published bulletin No. 186 entitled, "Corn Families of South Dakota." This bulletin was an attempt to set forth a definite plan wihch might be followed by practical corn breeders, at the same time making application of the scientific principles that are now fairly well known. Since the publication of the bulletin, the writer has attempted to set forth this system for corn breeding by presenting an actual plan still more definitely. A summary statement to that effect has been set down during the year past in a short article for the Journal of Heredity, entitled, "A System for Breeding Corn or Gregarious Animals."

On our west farm we have conducted a series of three separate acres of ten plots each, involving a comparison of a livestock and a grain system of farming. Results of these systems will be published in due course of time by Professor

Hutton, who has charge of soil investigations within our department. During the year the writer has taken occasion to summarize the yields from these series of plots into the following table:

Comparative Average Yields of Corn and Oats, from a (1) Grain System and a (2) Livestock System of Farming in Eastern South Dakota, 1911-1918 inclusive.

	Av. Yields from Grain Systems		Av. Yields from Livestock Systems	
Year	Corn	Oats	Corn	Oats
1911	27.7	1.8		3.1
1912	52.5	91.2	62.6	62.2
1913	47.4	50.4	51.0	59.1
1914	54.2	24.3	49.9	24.5
1915	15.4	79.0	14.9	54.9
1916	45.3	70.1	44.7	71.5
1917	39.6	99.8	36.1	102.2
1918	51.5	86.7	54.3	72.4
Average 1912–18	43.7	71.6	44.8	63.8
Average	57.6		54.3	

The preceding table makes it evident that the corn yields of 1912 and 1913 (the first two years when comparison was possible) were higher from the livestock system, receiving manure, than from the grain system, receiving crop residue. The reverse has been true however since 1912 until 1918 when for some reason the corn yields were slightly higher from the livestock system. At first examination, yields of oats appear more inconsistent, which may be due to the occasional loss of some oats through lodging.

As an average the yield of both corn and oats for the years 1912-1918 inclusive, has been higher from the grain system of farming where no stall manure was applied and where crop residues (mainly corn stover and oat straw) were returned to the soil, to be plowed under. The total average yield of both corn and also of oats per acre has been greater from the grain system where crop residues were returned, than where the equivalent in stall-manure was returned. The average yields of bushels of cereals (corn and oats) harvested

annually per acre from these systems has been somewhat higher (3.3 bushels) from the grain system than from the live stock system.

Field experiments have been conducted in plot form with varying depths of tillage including shallow plowing, deep plowing with the tillage machine and with the use of a subsoiler. Results acquired in the form of crop yields are not absolutely consistent, but there is no evidence accumulating which would indicate that any depth of tillage will measureably compensate for lack of rainfall or vice versa.

Cropping experiments are also conducted giving comparison of the efficency of acid phosphate and raw rock ground phosphate with and without manure, also comparing crop yields from plots with and without applications of ground limestone.

It may be inferred from the above that field experiments thus conducted with the use of Hatch funds are designed to cover numerous trials of systems that seem to us to be absolutely fundamental in their bearing upon South Dakota agriculture. As I indicated in the foregoing, it may or may not be the immediate object to arrive at the ultimate scientific principle involved. The latter however is not disregarded in any case.

The following bulletins and circulars have been published during the fiscal year just past, or are now ready for publication and in the hands of the printer:

No. 187—The Influence of Length of Wheat Heads on Resulting Crops.

No. 191—Water as a Limiting Factor in the Growth of Sweet Clover (M. Alba.)

Soil Survey Circular No. 1, Nitrogen from the Air.

Very respectfully,

A. N. HUME,

Agronomist and Superintendent of Substations.

DEPARTMENT OF CHEMISTRY

James W. Wilson,
Director.
Dear Sir:

The work in the division of chemistry for the fiscal year ending June 30, 1920, has been largely in cooperation with the work of other divisions of this station.

The division has cooperated with that of animal husbandry, in the analysis of silage and in a large number of analyses of wool samples as looking toward a determination of the effect of varied rationing upon wool constants. The work of the latter project, has been finished and the whole tabulated results have been placed in the hands of the director in a former report.

Respectfully submitted,
B. A. DUNBAR,
Station Chemist.

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DEPARTMENT OF DAIRYING

Mr. James W. Wilson,
Director of Experiment Station.
Dear Sir:

In compliance with your request I am glad to give you herewith a report of this department for the year ending June 30, 1920.

Changes in Staff: There have been no changes in the experiment station staff of this department during the past fiscal year.

Adams Fund: During the year there was published Bulletin No. 188 entitled "Relative Values of Feed Proteins for Dairy Cows." It contains the data and conclusions of this project which was finished during the previous fiscal year.

The only project prosecuted under Adams funds during the present year was the one outlined by Dr. H. P. Armsby, which is being carried on in cooperation with other stations. The object of this work is to determine the protein requirements for the growth of cattle.

During the past winter two pairs of dairy calves were fed upon two different plans of protein intake but with equal net energy supply. One calf of each pair was fed on a low protein ration and the other on a ration high in protein. The low protein ration supplied little more than the minimum amount theoretically required while the high protein ration

supplied about the amount demanded by current feeding standards.

Observations were made on these four calves for the past eight months. The weights and important measurements of the calves were taken and recorded weekly. These weights and measurements however, do not show as much difference as would be expected from rations which differ so in the amount of protein furnished. The most noticeable difference is in the condition of the hair and skin which shows more quality and glossiness in the case of the high protein calves.

The allotment on the Adams fund was $1519. It was expended as follows:

Calves	$259.00
Supplies	228.38
Labor	713.03
Feed	244.10
Equipment	74.49
	$1519.00

Hatch Fund:—The experimental work with milking machines is being continued. In March 1920 a new series of experiments was begun. It has a three-fold object: (1) to determine the relative economy of machine and hand milking; (2) to determine the efficiency of the various types and makes of mechanical milkers and (3) to study the bacterial count of machine produced milk and to determine how this count may be reduced.

During the two months April and May, 1920, the average time required for machine milking was 8 minutes as compared with 11 minutes for hand milking. The percent of strippings seems to vary considerably with the different machines but there does not seem to be any relationship between the stage of lactation and the percent of strippings.

The suction pipe line running from the vacuum tank to the stanchions was a source of bacteria unless steamed out or otherwise sterilized. After a thorough steaming of this pipe line the bacterial count of the milk was cut in half.

The allotment of the Hatch fund was $759. Of this, $633.25 was spent leaving a balance of $125.75 to be carried forward to next year. The expenditures were as follows:

Supplies	$316.87
Equipment	62.80
Labor	253.58
	$633.25

Local Station: Work is still being carried on in the grading up work by the use of good pure-bred dairy sires on scrub or grade cows. One foundation cow has given birth to four heifer calves, one of which is from a Holstein sire, another from a Jersey sire, the third from a Guernsey and the fourth from an Ayrshire.

We have records on the granddaughters of some of these foundation cows but these records were made as immature animals and consequently do not compare favorably with the records of the daughters. A comparison of the records of the daughters with those of their scrub dams is given below:

	Number of cows	Average lbs. milk	Average test	Average lbs. fat
Scrub cows	3	4338.3	4.05	175.51
Holstein Grades.	5	8575.4	3.57	307.80
Scrub cows	3	4338.3	4.05	175.51
Jersey Grades ..	3	5068.0	4.57	231.83
Scrub cows	1	5464.0	3.89	212.50
Guernsey Grades	1	5271.6	5.14	271.32

The records pertaining to the production, feeding and breeding of the dairy herd were kept as usual. No experimental funds, however, were used for this purpose. Everything produced on the dairy farm has been weighed and analyzed and reports kept of same.

The balance in the Local Station fund carried forward from last year was $1102.35 with an additional credit of $50 from sale of stock, making a total of $1152.35. The expenditures were $126.50 leaving a balance carried to next year of $1026.30. The expenditures were as follows:

Supplies	$ 27.90
General Expense	86.65
Equipment	11.50
	$126.50

Respectfully submitted,

C. Larsen,
Director of Extension and
Professor of Dairy Husbandry.

DEPARTMENT OF HORTICULTURE

James W. Wilson, Director,
Agricultural Experiment Station,
Brookings, South Dakota.

My dear Sir:

The frequent losses from winter killing in our fruit trees over so wide an area of the prairie northwest indicates the need of hardy varieties. Hence fruit breeding has been the main work of this department for a number of years. My standard of hardiness is 40 degrees below zero with the ground bare of snow and without protection of any kind. The busy prairie farmer will not take time to get the plants protected.

ADAMS FUND PROJECT: FRUIT BREEDING

Trees of the following varieties were sent out in the spring of 1920, all as one year buds on Red Siberian stocks:

Hopa Red-Flower Crab

Offered for the first time. Hopa is the Sioux Indian word for "beautiful." A promising addition to our list of ornamental trees for the lawn owing to its wealth of beautiful deep rose crimson blossoms. A striking sight when in bloom. The fruit is too small to be of value for eating, being less than one inch in diameter, but its bright red color will light up the tree in autumn, and the small size is an advantage as the tree is less apt to be stripped for fruit when standing on the lawn. Female parent Pyrus Malus Niedzwetzkyana, a small red-fleshed apple from Turkestan in the high mountains between Turkestan and China, male parent Pyrus Baccata. This was not a hand cross, but I am satisfied that the Baccata was the pollen parent. Trees of strong growth in nursery.

Cathay Crab

A round-topped dwarfish tree of considerable promise as an ornamental for the lawn. In bloom the tree is one huge bouquet of very large white flowers. The flowers are two and one-half inches in diameter, showing tendency to doubling. Offered for the first time spring 1919. Cathay is the ancient name for China, referring to its native home. One of our seedlings of Pyrus ringo descended from the original importation from Russia by Professor J. L. Budd. The name as now given in Bailey's Cyclopedia of Horticulture is Pyrus prunifolia, Willd. var. Rinki. This seedkong is a good representative of this species. Fruit, one and half inches in diameter; clear bright yellow all over with some orange blush. Calyx deciduous. Flesh clear, juicy, acid. Original tree has been very productive. The fruit cooks up as easily as Duchess, making a light yellow acid sauce of good flavor.

Red Tip Crab

Offered for the first time spring 1919. Female parent, a wild crab from Elk River, Minnesota; male parent, Pyrus Malus Niedzwetzkyana. The tree has not fruited and the pedigree does not indicate any promise as a table fruit, but the red-tipped young leaves make it an interesting tree from the ornamental standpoint.

Anoka Apple

First introduced spring 1918 before fruiting as South Dakota No. 2. Now given the name Anoka, a Sioux Indian word meaning "on both sides." It is a seedling of Mercer (Fluke) wild crab top-grafted on Duchess. This tree has borne heavily in 1918 and 1919. The fruit is two and one-half inches in diameter, round, Duchess type of coloring. Flesh white, good subacid. Season September. I am pleased with the early and heavy bearing of this variety under propagation.

Chance Apple

Offered for the first time spring 1919. The original tree bore a good crop again in 1919. One of our chance seedlings from mixed seed of northern grown apples. Original tree productive. Fruit oblate, regular, of full commercial size, red-striped all over with attractive blue bloom. Flesh white, pleasant subacid. Season probably January or later. I hope this will help some on the late-keeping apple problem. The fruit is certainly of attractive appearance.

Nocalyx Crab

Offered for the first time. A seedling of Spitzenburg crab. This is probably the largest apple with a deciduous calyx produced to date. Fruit round, two inches in diameter, yellow with red stripes. Sprightly subacid, with sweet after-taste. A very productive tree. Season September. This fruit has no calyx segments and no calyx tube open into the core. However, in the Nocalyx, Ivan, Amur and other crabs, the calyx segments are not always wholly deciduous, occasional specimens at times retaining their segments.

Sapinia Crab

Offered for the first time. This is a seedling of Winesap top-grafted on Virginia crab. The name is made up from these two names. One of the forerunners of a new race of hybrid apples, in which the cultivated apples instead of the Siberian crab is the female parent. Fruit thinly washed with dull red, almost two inches in diameter. Flavor subacid. Evidently a long winter keeper.

Some trees also were sent out of the Olga, Sugar, Dolgo, Alexis, Ivan, Amur and Izo described in former lists, all one year buds on Siberian crab stocks. Some trees were also sent

out of the Moscow cherry, first sent out in the spring of 1917, as one year buds on Mahaleb stock.

HATCH FUND PROJECT: ROSE BREEDING

The work in breeding hardy roses was continued on a large scale the past season and much seed was obtained.

SPECIAL STATE WORK WITH ALFALFA

June 30, 1919, ended the eighth year of special state appropriations under my direction for the propagation and distribution of alfalfas from various parts of Russia and Siberia. Among the plants left in the department plantations at the close of the work a white seeded and white flowered alfalfa appeared in the fall of 1919. We are endeavoring to fix this to come true to seed. The work with the white flowered alfalfa has given us a strain 97 percent true to the white color. If now we can get seed of a distinct color it will be a great help in preventing mis-labeling of seeds.

FIELD COLLECTING

The work of collecting northern material for plant-breeding work was continued. During the summer and fall of 1919 I made three tours to Manitoba and Saskatchewan. In Manitoba I went far north to LePas on the Hudson Bay railroad. Later the wild grape was located and plants secured from the Riding Mountain district near Dauphin, over 200 miles further north than it has been noted before. The native American plum was traced to near Oxbow, southern Saskatchewan, wihch is further northwest than has been recorded before, as far as I have been able to find a record. Many other plants were obtained. A sweet chokecherry free from the usual astringency was located in Manitoba near Valley River.

On my second tour, I attended the second annual meeting of the Association of Official Horticulturists of the Great Plains Region at Winnipeg, Brandon, Indian Head and Morden. On my third tour I went east to study in the Canadian National Herbarium at Ottawa, Canada, then to the Gray and Arnold Arboretum Herbariums of Harvard University at Boston, then to the New York Botanical Gardens of New York City and the Field Museum at the University of Chicago. The tour included wading through the Muskeg swamps in deep snow, in central Manitoba, in climbing Roan mountain in northeastern Tennessee, over 6,000 feet, in a drizzy rain.

The object of the herbarium work was to study type specimens of the plants under consideration. Later in the winter the work was continued in the herbarium of the Shaw Botanical gardens at St. Louis, while attending the annual meeting of the American Association of the Advancement of Science, the American Pomological Society and the

Society for Horticultural Science. This spring in apple blossom time I went south to Fayetteville, Arkansas; Mountain Grove, Missouri; Louisiana, Missouri, and Farmingdale, Illinois, for pollen of apples and pears for use in the northern work. Later I went to the woods of northern Minnesota.

While at the American Pomological Society at St. Louis I was a member of the committee of three on nomanclature for fruits. A new code was adopted.

More Land Needed

The most important orchard problem is a hardy winter apple. After raising fully 10,000 apple seedlings along many lines of pedigree, I have no seedlings that I am sure will be the ones needed. The evolution of this apple will probably be a step-by step process rather than a single step. My present plan is to make many combinations, especially of new and complex pedigree, and to bud from the resulting seedling as soon as possible, even before fruiting. This is to determine the growth in nursery and freedom from blight. These trees are budded on Siberian crab apple roots.

The new seedlings that have fruited the past two seasons have encouraged me greatly. I feel that the work is planned along the right lines and will result in a long list of desirable varieties. What is now needed is several hundred acres of additional land upon which these new seedlings may be fruited as soon as possible under good orchard conditions, and not in the closely planted nursery rows as at present. This additional land must soon be granted to permit suitable extension of this work, not only with apples but also plums, cherries, pears, grapes, raspberries, blackberries, strawberries and other fruits needed in the prairie northwest.

Without land upon which to plant these thousands of seedlings the new fruits will be only an iridescent dream. If we get land the new young seedlings will have a chance to develop and the work will go on to successful fruition. To do the work that should be done with fruits and new alfalfas and other forage plants I brought from Russia and Siberia, this department needs a $100,000 building and fruit-breeding greenhouse; 160 acres of good high dry land at Brookings, near the station; and a section of highest and driest land available in some representative portion of the state, such as in the uplands near Fort Pierre. This would give opportunity also for the development by you of the Siberian fat rump sheep which I brought over in 1913 and with which you as director of this station have done such excellent work in developing.

Yours truly,

N. E. Hansen,
Professor of Horticulture.

DEPARTMENT OF ENTOMOLOGY

Director James W. Wilson,
South Dakota Agricultural Experiment Station,
Brookings, S. D.

Dear Sir:

In response to your request, I send you herewith a report of the experiment station work conducted by the entomology department for the fiscal year ending June 30, 1920. The projects that are being investigated are all financed through Adams funds. Projects 2 and 3 are conducted under the leadership of H. C. Severin while project 4 is carried on under the guidance of Geo. Gilbertson.

Adams Project II

Title: The Webspinning Sawfly of Plum and Sandcherry (Neurotoma inconspicua (Norton) Mac Gillivray)), its distribution, food plants, economic importance, life history, habits, natural enemies and control. This project was completed during the past year and the results obtained were written in bulletin form and are now in the hands of the printer.

The plum webspinning sawfly is distributed generally over South Dakota but it is the eastern half of the state that suffers most severely from the ravages of the larvae of this pest. The larvae are gregarious and live and feed in webs which they spin about the leaves and twigs of their food plants. The foliage of plum trees and sandcherry bushes constitutes the preferred food of the pest and such trees and bushes may be entirely defoliated during June and July.

The adult insects make their appearance during the latter part of May or early June. After mating, each female lays 46 eggs on an average and these, after a period of 5 to 7 days, give rise to larvae or "worms." The "worms" feed for 12 to 23 days and at the end of this period they fall to the ground, enter it to a depth of 1 to 10½ inches and hollow out cells, inside of which they pass the remainder of the summer, and all of the fall, winter and early spring. With the approach of warm weather in the spring, the "worms" change to pupae and these give rise to adults or sawflies in 7 to 10 days. Thus it is seen that there is but one generation of this pest per year.

While there are several very effective parasites and predaceous enemies of this insect, they do not keep down the numbers of the Neurotoma larvae to the point where their presence upon plum trees or sandcherry bushes is negligible.

Consequently, spraying or dusting must be resorted to. If spraying is practiced, 1 pound of lead arsenate in paste form or ½ pound in the powdered form should be used for each 50 gallons of water, but if dusting is adopted, then 1 pound of powdered lead arsenate should be diluted with 15 pounds of air-slaked lime or powdered sulphur before it is applied to the foliage. The spray or dust should be applied to the fruit trees or bushes while the webs of this pest are still small.

Adams Project III

Title: Distribution, life history, economic importance, natural enemies and control of the common field cricket (Gryllus abbreviatus Serv.)

Considerable was learned during the past year regarding the life history, habits and distribution of this pest but much remains yet to be discovered. The injury done by Gryllus abbreviatus was also investigated and included the following:

(1) damage to alfalfa seed pods
(2) damage to alfalfa seed
(3) damage to uncut grain
(4) damage to shocked grain
(5) damage to binder twine
(6) damage to goods made of paper
(7) damage to goods made of cloth

Alfalfa seed pods are either cut off entirely from the plants and dropped to the ground or the developing pods are ruined by having holes chewed into them. When the pest has opened up a seed pod, it pulls out the developing seed and devours it. In some sections of the state where the production of alfalfa seed is an important item, fully 40 percent or even more of the seed may be destroyed by this insect. Uncut grains and shocked grains do not suffer as much as does alfalfa. Binder twine may be cut in large quantities during some years and not cut in others, even tho the pest is present in large numbers during both years. As far as we have been able to determine, no one particular brand or make of twine is immune from cricket injury.

Two egg parasites of Gryllus abbreviatus were discovered, Geratoteleia marlatti Ashmead and Paridris n. sp. Of these, the former is far more abundant than the latter and consequently is also more important from an economic standpoint.

A tachinid fly, Exoristoides johnsoni Coq., was reared from an adult cricket. This specimen of fly according to J. M. Aldrich, was the hitherto unknown male of this species.

Other parasites which we discovered obtaining their livelihood from Gryllus abbreviatus, were an unidentified wasp, an unidentified thread worm, and two mites, Euthrombidium sp. closely related to debilipes Leonardi, and a species of Gamasidae. The latter is probably predaceous. Euthrombidium debilipes has been reported thus far only from Russia according to Doctor H. E. Ewing.

Control measures for this pest which we have tried and are able to recommend are the following:

1. Plow or disk and harrow in the fall all fields where cricket injury was experienced during the year. Special care should be taken to plow or disk and harrow the edges of fields and roadsides. This treatment is for the purpose of destroying the eggs of the pest.

2. Renovate alfalfa fields in the fall. This treatment destroys the cricket eggs.

3. Cocks or stacks of old hay or alfalfa may serve as a place of refuge for thousands of crickets. When the insects have gathered under these places of protection, the vegetation should be set afire all around the basal edges. Weeds cut, raked into piles and allowed to lie on the ground for sometime, also attract crickets. The piles should then be burned as were the cocks and stacks of hay.

4. If grasshoppers and crickets are both abundant in a field the bait made according to the following formula should be used to destroy the hoppers and incidentally some of the crickets:

Bran	25 pounds
Black strap molasses	2 quarts
*Oranges	3
White arsenic or paris green	1 pound
Water	4 gallons

*In our experiments, the absence of oranges in the bait made no appreciable difference in the killing results which we obtained.

During the past few years we have used many different kinds of baits to kill crickets, but under field conditions none of the baits yielded satisfactory results. When a number of crickets, a bait and alfalfa were placed in jars in the laboratory, the crickets would die within one to ten days, but when these baits were sown broadcast through alfalfa fields, comparatively few crickets would be found dead in the field. It was discovered that many of these dead crickets had become poisoned by feeding upon such hoppers as had died from the effects of eating the poisoned bait.

Adams Project IV

Title: The Wheat Stem Maggot (Meromyza americana Fitch), its distribution, food plants, economic importance, life history, habits, natural enemies and control.

A considerable share of Mr. Gilbertson's station time was taken up in locating and reading the literature dealing with this pest. Thus far thirty publications have been digested.

The distribution of Meromyza americana has been fairly well determined as was also the injury done by it. In wheat, the loss due to this pest ranged from less than one to 15 per cent or more while in barley fields the loss fluctuated from less than one to four percent or more. In oat fields little damage was done. The infestation in different varieties of wheat was also investigated. Grasses, both wild and tame, were studied to learn if they become infested with the larvae of the pest and if so to what degree.

The life history of this insect is very difficult to determine because of overlapping of the broods and because of the prolonged life and oviposition period of the adults. However, some headway has been made and much valuable information obtained. The longevity of the flies has been worked out as were also the mating habits, the preoviposition period, and the behavior in egg-laying.

The egg has been described and the egg-laying possibilities has been studied. The incubation period of the egg has been determined as was also the issuance of the larva from the egg.

The duration of the larval stages was determined but the description of each larval instar needs further investigation. The actions of the larva and its effect upon the host plant have been closely analyzed and recorded.

Pupation has been observed and a description of the pupal stage has been written up. The duration of this stage and the emergence of the fly from the pupa have also been studied.

Two parasites, Microbracon meromyza Gah. and Coelinidea meromyzae Forbes were found destroying meromyza larvae. The predaceous mite, Pediculoides ventricosus was discovered feeding on the larvae of the wheat stem maggot, while an unidentified mite was discovered gaining its livelihood from the adult flies.

A poisoned bait spray to kill Meromyza flies was used in some of our indoor work with wonderful results. If this can

be made practicable on a large scale out-of-doors, a solution for the control of this pest will have been discovered.

A number of oils were used in pans to attract and kill the flies of this pest but thus far, our results have been discouraging with these materials.

Respectfully,

H. C. Severin,
Entomologist.